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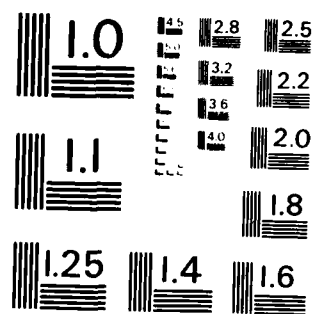
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# BALANCING ACCESSION AND RETENTION: THE AGGREGATE MODEL

Ellen Balis  
Deborah Clay-Mendez

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BALANCING ACCESSION AND RETENTION:  
THE AGGREGATE MODEL

SUMMARY

Ratings of four-year obligors were aggregated into 6 groups plus a GENDET group. The simulation model developed in this study was then used to find optimal reenlistment bonus, accession, and assignment policies. Overall, results show that least-cost bonuses are above current levels.

## BACKGROUND

The model developed for this study is designed to help select the recruit assignment, accession and reenlistment bonus policies that minimize the total cost of meeting LOS-5 requirements. A disaggregate version of this model and a description of the data used to analyze it are presented in reference (1). This paper focuses on an aggregate version of the model, which uses 7 rating groups. Solving the problem then involves selecting 7 assignment probabilities and an accession level for each quality type, and 6 zone A bonus levels. The GENDET population is constrained to have a zero bonus multiple, since we have no estimate for its responsiveness to pay. Reducing the problem to this size allows us to find optimal values for each variable. All of the interactions between policy variables for the different rating groups can be taken into account.

Theoretically, we show that optimal bonus levels depend on the total cost per reenlistment eligible individual, and the responsiveness of individuals to pay (reference 2). Ratings were thus grouped based on A-school costs, a close proxy for cost per eligible, and the estimate of  $b$ , the slope in the equation for the responsiveness of reenlistment behavior to pay. Ideally, the intercept from this equation should also be used in grouping. However, this would increase the number of variables to be calculated beyond a level that can be analyzed by our model. It is, therefore, best to view results as illustrative and not



definitive for setting multiples for particular ratings. The 7 rating groups are listed in table 1.

TABLE 1

RATING GROUPS<sup>a</sup>  
A-SCHOOL COSTS

Responsiveness To Pay	High	Medium	Low
	Group 1	Group 2	Group 3
Low	MS, OS, QM	AC, AW, BT, DM, EM, EN, GM, GS, HT, IC, JO, LI, MM, MU, PH, RM, TM	EW, EM, ML, MN, OM, OT, PM, ST
	Group 4	Group 5	Group 6
High	AB, AD, AG, AK, AM, AO, AS, AZ BM, BU, CE, CM, DK, DP, EA, EO MS, PC, PN, PR, SH, SK, SM, SW, UT, YN	DT, FT, HM	AE, AQ, AT, AX, CT, DS, ET, IS, TD

<sup>a</sup>Group 7, GENDETS.

Algebraically, the aggregate model is identical to the original simulation model. Required data elements are based on data developed for the individual groups. Requirements and the probability of GENDETS qualifying for a given rating were summed across individual groups to derive the appropriate number for the aggregate model. For all other

variables, the median value was selected to eliminate the effect of outliers.

Given a set of bonus multiples, the model operates by determining the number of individuals who must be eligible to meet requirements. The bonus multiples determine the total continuation rates between LOS 4 and 5. Given the number of eligibles required and the data developed for the model, the number of NPS 4YO males who must be assigned to each rating after recruit training can be determined. Appendix A contains the equations that relate the numbers of individuals assigned to each rating to the number of reenlistment eligibles in each rating four years later.

The equations show that the most important determinant of the number of eligible individuals in a rating is the number of individuals originally assigned to it. The original GENDET population supplies the second largest flow to each rating group. Other flows represent A-school failures who become GENDETs and later qualify in another rating.

#### CURRENT FORCE

Figure 1 shows the flow of individuals from recruitment to the reenlistment decision, given current bonus levels. The initial level of recruits and their assignment probabilities were calculated based on the number of individuals eligible to reenlist in each rating in FY 1981.

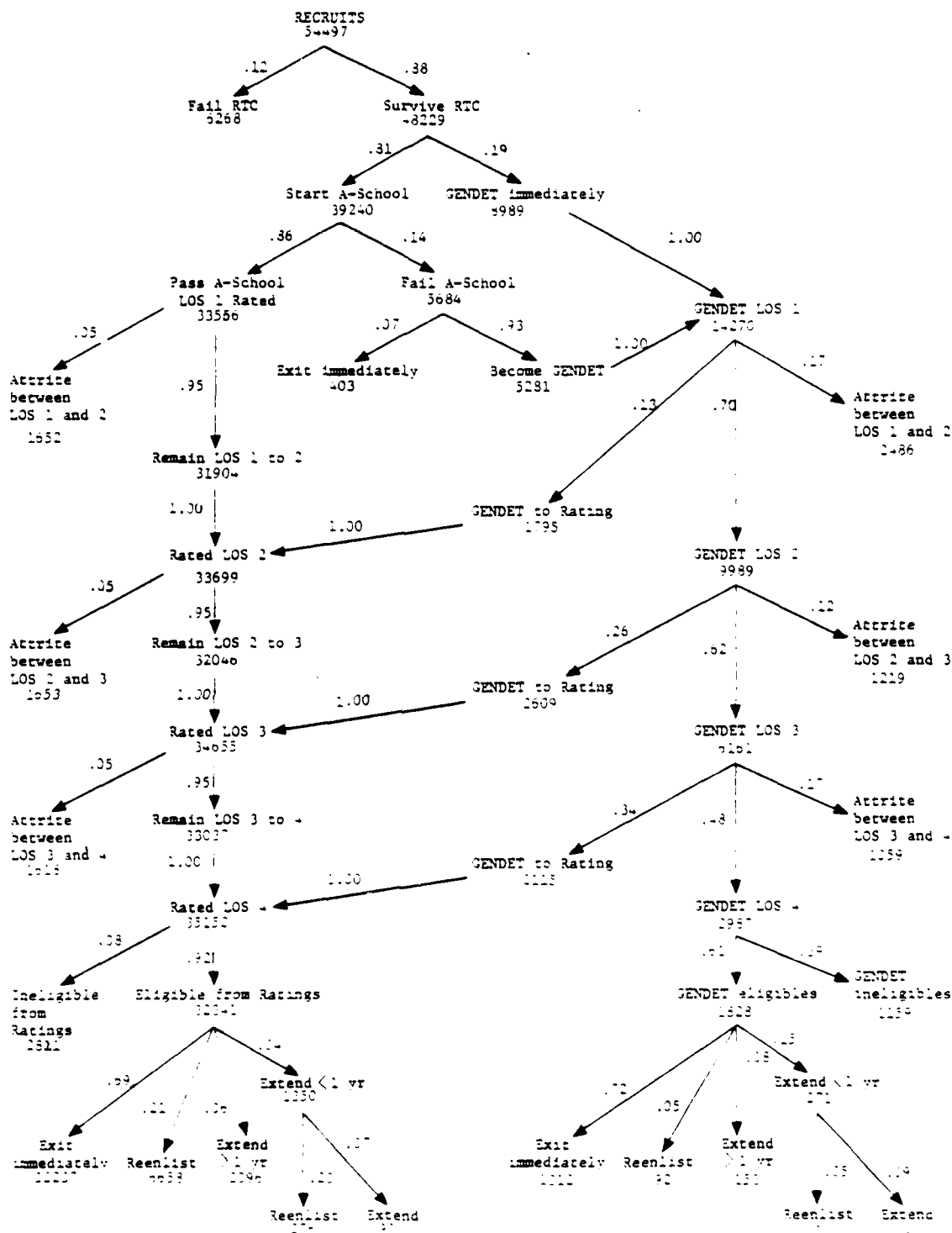


FIG. 1. MODEL FLOW CHART

In table 2, column 1 shows the yearly steady-state costs of recruiting, training, and bonus payments under current (1981) policies in 1982 dollars. A-school training costs represent 50 percent of total costs, while bonus costs account for 5 percent. Column 2 presents the cost of sending a single cohort from recruitment to the start of LOS 5. Here, expenses that do not occur in the first year are discounted at an annual rate of 10 percent.

TABLE 2  
CURRENT POLICY (FY 81)

	Group					
	1	2	3	4	5	6
Bonus Multiple:	3.2	2.9	1.9	0.4	0.6	1.6
	Yearly Costs (in millions)			Cohort Costs (in millions)		
Total	553			537		
Recruiting	112			112		
Recruit Training	137			137		
A-School Training	274			267		
Bonus	30			21		
	<u>Recruits</u>					
HSDG	38,000					
NHSDG	17,000					

The aggregate model was used to find optimal recruiting, assignment, and bonus policies. All possible combinations of bonus multiples, where an individual rating's multiple could vary from 0 to 19, were simulated, and an associated cost of sending a cohort from recruitment through the reenlistment decision was calculated for each. Policies associated with the minimum value of these costs are shown in

table 3. For all rating groups, bonuses are higher than under current policies. In each case, the bonus multiple at the same level of A-school costs is higher for the group with lower responsiveness to pay. Whereas at each level of pay responsiveness, the optimal bonus multiple increases with increases in A-school costs. For example, the optimal bonus level is 11, for the group with low responsiveness to pay and low training costs, but 13 for the group with low responsiveness to pay and medium A-school costs. The increase in A-school costs is translated into an increase in the value of a reenlistment, and thus a higher bonus multiple is optimal.

TABLE 3  
LEAST COST SOLUTION FOR OBSERVED FORCE

	Group					
	1	2	3	4	5	6
Bonus Multiple:	11	13	19	5	10	11
	Yearly Costs (in millions)			Cohort Costs (in millions)		
Total	496			424		
Recruiting	53			53		
Recruit training	85			85		
A-school training	152			145		
Bonus	206			141		
	<u>Recruits</u>					
HSDG	23,000					
MHSDG	12,000					

Total costs for each cohort shown in column 2, are 21 percent below current levels. Actual savings to the Navy of a permanent switch to this bonus policy is \$1303 million. This savings represents both a long

run reduction in yearly expenses, and a one time savings. The latter results from reduced recruiting and training budgets in the first year and no increase in bonus costs until the new cohort reaches the reenlistment decision. After the new bonus budget takes effect, savings would be \$57 million per year. Column 1 of table 3 shows the new breakdown of yearly costs. Bonus costs make up 42 percent of the total budget as compared to 5 percent under current policies. Because of higher bonus levels, fewer individuals need to be recruited and trained. At the least cost solution, LOS 1-4 manning is reduced by 42 percent.

Since the reduction in LOS 1-4 manning is large under least cost policies, a second set of simulations was run limiting the decline in first term manning levels to 15 percent in any given rating group. Table 4 presents the least cost solution given this constraint. Constraints on manning levels are all binding. The aggregate decline in first-term manning relative to current levels is now 9 percent. Bonus levels are above current levels for all rating groups.

TABLE 4  
CONSTRAINED LEAST-COST SOLUTION

	Group					
	1	2	3	4	5	6
Bonus Multiple:	5	4	4	2	2	3
	Yearly Costs (in millions)			Cohort Costs (in millions)		
Total	525			497		
Recruiting	94			94		
Recruit training	124			124		
A-school training	245			237		
Bonus	62			42		
	<u>Recruits</u>					
HSDG	34,000					
NHSDG	15,000					

Total costs for each cohort are 7 percent below costs under current policies. Total savings associated with a permanent change to these policies are \$374 million. Yearly savings, in the long run are \$28 million. A-school costs are 47 percent of the yearly budget, while bonus costs are 12 percent.

#### OBJECTIVE FORCE

Next we ran simulations using the Navy's FY 81 objective force requirements. The 1981 LOS 5 objective force requirements give manpower needs for this length of service cell in 1986. These requirements are 39 percent higher than current LOS 5 manning. Table 5 shows the cost of meeting these requirements given current bonus policy. Although requirements increase by only 39 percent, total annual costs have

increased by 61 percent. This occurs because requirements rise disproportionately in the high A-school cost rating groups. The total increase in costs resulting from the larger force is \$3437 million.

TABLE 5  
CURRENT POLICY APPLIED TO OBJECTIVE FORCE

	Group					
	1	2	3	4	5	6
Bonus Multiple:	3.2	2.9	1.9	0.4	0.6	1.6
	Yearly Costs (in millions)			Cohort Costs (in millions)		
Total	893			869		
Recruiting	217			217		
Recruit Training	194			194		
A-School Training	435			426		
Bonus	47			32		
	<u>Recruits</u>					
HSDG	55,000					
NHSDG	23,000					

Using the same procedure as for the current force, we find an optimal solution for the objective force. As anticipated, bonus levels, as shown in table 6, are higher for the larger force. Total savings from a switch to these higher bonus levels in this case are \$2258 million. Annual costs are reduced by \$143 million.



TABLE 6

## LEAST COST SOLUTION FOR OBJECTIVE FORCE

	Group					
	1	2	3	4	5	6
Bonus Multiple:	12	13	19	6	10	11
	Yearly Costs (in millions)			Cohort Costs (in millions)		
Total	750			634		
Recruiting	78			78		
Recruit training	112			112		
A-school training	223			214		
Bonus	337			230		
	<u>Recruits</u>					
HSDG	30,000					
NHSDG	15,000					

## EFFECT OF TARGETED RELATIVE TO UNTARGETED BONUSES

We have used the aggregate model to find optimal bonus levels under several scenarios. Next, we examined the question of whether these targeted bonuses are more effective than an across-the-board bonus multiple.

Current bonus policies are compared to an untargeted bonus policy. An across-the-board multiple equal in cost to the current bonus budget was found to be 1.48. Simulating the effect of this policy reveals that it is more expensive than current bonus policies. Table 7 shows that training and recruiting budgets are higher than current levels. The Navy saves \$13 million annually by targeting bonuses rather than using a single bonus multiple in every rating.

TABLE 7  
GENERAL BONUS MULTIPLE RELATIVE TO CURRENT POLICY

	<u>Yearly Cost</u> <u>(in millions)</u>	<u>Savings Compared</u> <u>to Current Policy</u> <u>(in millions)</u>
Total	566	-13
Recruiting	115	-3
Recruit training	139	-2
A-school training	252	-8
Bonus	30	0

Using the model, we were able to develop an alternative set of bonus multiples which although using the same aggregate bonus payments yield lower total costs. The change in bonus multiples although not an optimal solution was based on the relative size of the multiples in the optimal case. It does result in savings, as table 8 shows, of \$2 million annually when compared with current policy. All of the savings is in A-school training costs. This is because emphasis was placed on raising multiples in the high training cost ratings where the value of a reenlistment is highest.

TABLE 8  
ALTERNATE POLICY RELATIVE TO CURRENT POLICY

	Group					
	1	2	3	4	5	6
Bonus Multiple:	2.0	2.9	4.7	0.4	1.4	1.6
	Yearly Costs (in millions)			Savings Compared to Current Policy (in Millions)		
Total	551			2		
Recruiting	112			0		
Recruit Training	137			0		
A-School Training	272			2		
Bonus	30			0		

#### CONCLUSIONS FROM AGGREGATE MODEL

In all cases, least cost bonus levels are above current bonus levels. Optimal levels are higher for ratings with higher A-school costs. As the size of the career force grows, optimal bonus levels increase. Correctly targeted bonuses are more effective than untargeted or across-the-board bonuses.

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# APPENDIX A

## RELATIONSHIP BETWEEN ORIGINAL TRAINING ASSIGNMENTS AND SUBSEQUENT ELIGIBILITY

### EQUATIONS FOR QUALITY TYPE 1

$$.737X(1,1) + .002X(1,2) + .003X(1,3) + .001X(1,4) + .005X(1,5) + .006X(1,6) + .021X(1,7) = \text{ELIG}(1,1)$$

$$.018X(1,1) + .752X(1,2) + .020X(1,3) + .006X(1,4) + .037X(1,5) + .050X(1,6) + .168X(1,7) = \text{ELIG}(1,2)$$

$$.001X(1,1) + .001X(1,2) + .720X(1,3) + 0.00X(1,4) + .003X(1,5) + .004X(1,6) + .013X(1,7) = \text{ELIG}(1,3)$$

$$.027X(1,1) + .025X(1,2) + .028X(1,3) + .801X(1,4) + .054X(1,5) + .072X(1,6) + .243X(1,7) = \text{ELIG}(1,4)$$

$$.001X(1,1) + .001X(1,2) + .002X(1,3) + 0.00X(1,4) + .630X(1,5) + .004X(1,6) + .013X(1,7) = \text{ELIG}(1,5)$$

$$.007X(1,1) + .006X(1,2) + .007X(1,3) + .002X(1,4) + .013X(1,5) + .579X(1,6) + .059X(1,7) = \text{ELIG}(1,6)$$

$$.014X(1,1) + .013X(1,2) + .015X(1,3) + .005X(1,4) + .028X(1,5) + .038X(1,6) + .127X(1,7) = \text{ELIG}(1,7)$$

### EQUATIONS FOR QUALITY TYPE 2

$$.512X(2,1) + .003X(2,2) + .003X(2,3) + .001X(2,4) + .003X(2,5) + .004X(2,6) + .010X(2,7) = \text{ELIG}(2,1)$$

$$.020X(2,1) + .509X(2,2) + .020X(2,3) + .008X(2,4) + .026X(2,5) + .035X(2,6) + .078X(2,7) = \text{ELIG}(2,2)$$

$$0.00X(2,1) + 0.00X(2,2) + .489X(2,3) + 0.00X(2,4) + .001X(2,5) + .001X(2,6) + .002X(2,7) = \text{ELIG}(2,3)$$

$$.033X(2,1) + .034X(2,2) + .033X(2,3) + .625X(2,4) + .042X(2,5) + .056X(2,6) + .126X(2,7) = \text{ELIG}(2,4)$$

$$.001X(2,1) + .001X(2,2) + .001X(2,3) + .001X(2,4) + .442X(2,5) + .002X(2,6) + .005X(2,7) = \text{ELIG}(2,5)$$

$$.004X(2,1) + .004X(2,2) + .004X(2,3) + .002X(2,4) + .005X(2,5) + .364X(2,6) + .015X(2,7) = \text{ELIG}(2,6)$$

$$.034X(2,1) + .035X(2,2) + .034X(2,3) + .013X(2,4) + .043X(2,5) + \\ .058X(2,6) + .130X(2,7) = ELIG(2,7)$$

where  $X(i,j)$  = number of individuals of quality  $i$  who successfully complete recruit training and are assigned to the  $j$ th A-school

$ELIG(i,j)$  = number of reenlistment eligible individuals of quality type  $i$  in rating  $j$  during LOS 4

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